REMARKS/ARGUMENTS

Favorable reconsideration of this application, in light of the present amendments and following discussion, is respectfully requested.

Claims 1-16 and 41-46 are pending. Claims 19, 20, 22, 23, 28, 29, 31, 32, 34, and 36-40 were canceled previously. Claims 17, 18, 21, 24-27, 30, 33, and 35 were canceled by the present amendment. Claims 41-46 are newly added and are withdrawn. Support for newly added Claims 41-46 can be found in original Claims 24, 27, and 30. Claims 1, 6, 7, and 13 are amended. Support for the amendments to Claims 1 and 7 can be found in Fig. 2 and the description thereof, for example. Support for the remaining amendments is self-evident. No new matter is added.

In the outstanding Office Action, Claims 1-16 were rejected under 35 U.S.C. § 103(a) as obvious over Eichman et al. (U.S. Patent No. 5,279,857, herein "Eichman").

Regarding the rejection of Claims 1-16 as obvious over Eichman, that rejection is respectfully traversed by the present response.

Amended independent Claim 1 recites, in part:

> a first step of supplying the metal compound gas and the nitrogen-containing reducing gas into the process container, thereby forming a film of a metal nitride by CVD;
>
> then, a first purge step of supplying a purge gas into the process container without supplying the metal compound gas and the nitrogen-containing reducing gas into the process container, thereby purging the process container;
>
> then, a second step of supplying the nitrogen-containing reducing gas into the process container without supplying the metal compound gas into the process container; and
>
> then, a second purge step of supplying a purge gas into the process container without supplying the metal compound gas and the nitrogen-containing reducing gas into the process container, thereby purging the process container,
>
> wherein the film formation temperature is set to be less than 450°C, the process container is set to have therein a total pressure of more than 100 Pa in the first and second steps, and the nitrogen-containing reducing gas is set to have a partial pressure of 30 Pa or less within the process container in the first step.

Amended Claims 1 and 7 have been drafted to clarify that the film formation method is preset to repeat a plurality of times a cycle alternately comprising first and second steps of supplying process gases into the process container and first and second purge steps of purging the process container. This feature is supported by FIG. 2 and paragraphs [0046] to [0048] in the specification, for example.

By use of such cycle repetition and a partial pressure of 30 Pa or less of the nitrogen-containing reducing gas in the first step, a metal nitride film can be formed with a low resistivity and no abnormal growth, even where the film formation temperature is as low as less than 450°C. One example of this feature is described in FIG. 3 and paragraph [0060] of the present specification.

It should be noted that, where the nitrogen-containing reducing gas is set to have a partial pressure of 30 Pa or less in the first step, the throughput will typically be decreased, which is usually undesirable in view of demands for higher throughput. However, the methods recited in Claims 1 and 7 accept a decrease in throughput as a sacrifice to make the film formation temperature lower. The recited methods focus on a decrease in the film formation temperature in light of the following matters.

For example, there is a case where a high dielectric constant material, such as Ta_2O_5 or HfO_2, is used as a capacitor material in, e.g., DRAM devices, and an upper electrode is formed thereon with higher coverage. In this case, since the high dielectric constant material is sensitive to temperature, the upper electrode should be formed at a lower temperature of, e.g., less than 450°C. The upper electrode may be formed of a metal nitride film, such as a TiN film, which may cause a problem such that abnormal growth occurs due to a lower film formation temperature during formation of the metal nitride film and brings about degradation in film quality and increase in resistivity. The methods recited in Claims 1 and 7 can solve or ameliorate such a problem.

On the other hand, Eichman describes a method for forming a TiN film on a target substrate by LPCVD using $TiCl_4$ gas and NH_3 gas. This method is conceived to form a chlorine-free TiN film, because conventional TiN films typically contain a large amount of chlorine therein.

Specifically, at first, $TiCl_4$ gas and NH_3 gas are supplied into the process container and a TiN film is thereby formed on a target substrate. Then, as an annealing step, the $TiCl_4$ gas is stopped, while the NH_3 gas is still supplied as a hydrogen-bearing gas. For example, regarding applying NH_3 gas after $TiCl_4$ gas stops, Eichman states:

> The present process of using NH_3 gas to react and strip off the remaining unbound chlorine is preferably performed insitu **at the end of the TiN growth cycle** as a post deposition process.[1]

Thus, Eichman continues to supply NH_3 gas at the end of the TiN growth cycle. Consequently, residual Cl in the TIN film reacts with hydrogen and is thereby removed (for example, from column 1, line 65).

In contrast, the method recited in amended independent Claim 1 and the method recited in amended independent Claim 7 each provides first and second purge steps. The first purge step occurs after the first supply step, which supplies a metal compound gas and a nitrogen-containing reducing gas into the process container. The first purge step occurs before a second supply step in which nitrogen-containing reducing gas is supplied into the container without supplying a metal compound gas. Eichman is silent regarding the above-noted first purge step. Additionally, Eichman is silent regarding the second purge step noted above.

Additionally, although the film formation temperature of the TiN film is not mentioned in detail in the reference, it understood by persons of ordinary skill in the art that this temperature is typically set to be the same as the annealing temperature of 600 to 700°C

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[1] Eichman, col. 2, lines 45-48 (emphasis added).

(for example, from column 3, line 30). Even if the film formation temperature differs from the annealing temperature, it should be set to be relatively close to the annealing temperature to shorten the annealing time. Therefore, this temperature would not correspond to the temperature recited in the amended independent claims.

In light of the discussion above, Applicants respectfully submit that it is established that Eichman is silent regarding use of the cycle repetition and a partial pressure of 30 Pa or less of the nitrogen-containing reducing gas in the first step to make the film formation temperature lower while accepting a decrease in throughput as a sacrifice.

For the foregoing reasons, it is respectfully submitted that this application is now in condition for allowance. A Notice of Allowance for Claims 1-16 and 41-46 is earnestly solicited. Should Examiner Nguyen deem that any further action is necessary to place this application in even better form for allowance, he is encouraged to contact Applicants' undersigned representative at the below-listed telephone number.

Respectfully submitted,

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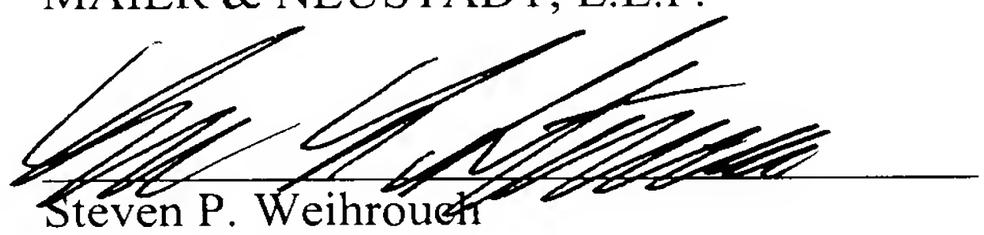

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